REMARKS

By this amendment, claims 1-20 are pending in the application, of which, claims 1, 9, 19 and 20 are being amended.

The language added to claims 1 and 9 of substantially an entire thickness of the silicon nitride film is supported at least by page 3, para 11, lines 20-23.

The language added to claim 19 of exposing the silicon nitride film to electron beam current at doses in a range from about 100 $\mu C/cm^2$ to about 1000 $\mu C/cm^2$ is supported at least by original claim 4.

Claim 9 has been corrected to substitute "source" for "course" which was a typographical error to overcome the examiner's objection to the claim.

The amendments are fully supported by the originally filed Specification and original claims and add no new matter. Entry of the amendments and reconsideration of the present case is respectfully requested.

Rejection of Claims 1-8 under 35 USC 103 (a)

1. The Examiner rejected claims 1-8 under 35 USC 103(a) as unpatentable over Ross (USP 6,548,899) in view of Lee et al. (USP 6,664,172).

This rejection is respectfully traversed because the combination of Ross et al. and Lee at al. does not teach the claimed method of treating a silicon nitride film to reduce a H content in the film by forming a silicon nitride film and electron beam treating the silicon nitride film at a sufficiently high electron dosage to reduce a H content of substantially an entire thickness of the silicon nitride film, as claimed in claim 1.

Ross et al. does not teach a method of fabricating a silicon nitride film and instead teaches methods of fabricating a dielectric film by curing a liquid polymer. Furthermore Ross et al. teaches a method of treating the surface of the dielectric polymer film, and does not teach treating substantially an entire thickness of a silicon nitride film as claimed in claim 1. Ross et al. gives numerous examples of dielectric films which are polymers in for example, Col. 3, line 1 to Col. 4 line 56. The numerous dielectric film examples given by Ross et al. specifically do not include a silicon nitride film, and are mostly directed to liquid organic polymers which need to be cured.

Second, Ross et al. teaches electron treatment of the polymeric dielectric film to remove moisture and contaminants from the surface of the polymer film – not to remove H from substantially an entire thickness of a silicon nitride film as claimed. The surface treatment of Ross et al. prepares the cured dielectric film for subsequent CVD of other layers on its cured surface. Specifically, Ross et al. teaches:

> The present invention relates to cured dielectric films and to a process for the treatment of the surface of such films to remove moisture and other contaminants therefrom. Such treatment is done by electron beam exposure of the dielectric surface in order to prepare it for a subsequent chemical vapor deposition of oxide, nitride or oxynitride layers.

Thus, Ross et al. does not provide any motivation to treat the entire thickness of a silicon nitride film, and further does not teach or suggest treating the film to remove H from the film as claimed.

Third, Ross et al. mentions that the substrate can have a silicon nitride film underneath the polymeric dielectric film but Ross et al. specifically teaches that the electrons should only reach a small thickness into the surface of the film, and consequently, teaches that the electrons should not reach the underlying silicon nitride. Ross et al. teaches surface treatment that reaches only to a depth of 1000 angstroms into the polymeric film, not even the entire polymeric film, let alone any underlying

silicon nitride film that lies below the thickness of the polymeric film. Ross et al. teaches:

> ... [a] dielectric layer having a thickness of from about 2,000 to about 50,000 angstroms; heating a surface of the dielectric layer and exposing the dielectric layer to an electron beam radiation, in which the electron beam radiation is concentrated at a distance within about 1,000 angstroms from the surface of the dielectric layer, under vacuum conditions to remove substantially all moisture and/or contaminants from the surface of the dielectric layer at a depth of up to about 1,000 angstroms from the surface of the dielectric layer. (Abstract) [Emphasis added.]

The optional silicon nitride layer taught by Ross et al. lies below the cured dielectric film, and since the electrons only reach to less than 1000 angstroms of the 2000 to 50,000 angstrom thickness of the cured dielectric film, the electron treatment of the surface of the cured dielectric film does not reach the underlying silicon nitride.

Furthermore, as acknowledged by the Examiner "Ross and does not explicitly disclose treating the silicon nitride film with a sufficient high electron dosage to reduce a H content of the silicon nitride film." The electron dosage taught by Ross et al. is intentionally selected to reach only 1000 angstroms of the surface of a polymer film and not the entire thickness of the film. By teaching treatment of only the surface of the polymer film, Ross et al. does not suggest or teach an electron dosage sufficient to reach the entire thickness of a silicon nitride film as claimed.

Lee et al. does not make up for the deficiencies of Ross et al. because Lee et al. also does not disclose treating a silicon nitride film with a sufficiently high electron dosage to reduce a H content of the silicon nitride film. Instead Lee et al. teaches a blanket ion implantation process to implant fluorine atoms into a silicon nitride layer so that "the implanted fluorine atoms will capture the hydrogen atoms in the silicon nitride layer to fix the rapidly defusing hydrogen atoms in their original locations, so that they do not readily [to] diffuse into the Si-SiO_2 interface." (Col. 5, lines 8-28.) The ion implantation of fluorine is not an electron beam treatment. Nor does the ion implanting treatment remove H content, and instead only fixes H to locations in the film surface.

Thus, the combination of Ross et al. and Lee et al. do not teach claim 1. Ross et al. teaches surface treatment of a polymer and does not mention silicon nitride. Ross et al. also does not teach or suggest treatment of a silicon nitride film to reduce its H content through substantially the entire thickness of the film. A teaching to an electron dosage for surface treatment as in Ross et al., is not a teaching to an electron dosage to treat substantially an entire thickness of a film as claimed. Lee et al. does not make up for the deficiencies of Ross at al. because Lee et al. teaches ion implantation of fluorine atoms and not electron treatment.

For these reasons, the combination of Ross et al. and Lee et al. does not teach electron beam treatment of a silicon nitride film in an electron dosage sufficient to reduce a H content through substantially the entire thickness of the silicon nitride film, as claimed in claim 1, or claims 2-8, which are dependent therefrom. Thus, the Examiner is respectfully requested to withdraw this rejection and allow claims 1-8.

2. The Examiner further rejected claims 9-18 under 35 USC 103(a) as unpatentable over Lee et al. (USP 6,664,172) in view of Ross (USP 6,548,899).

The combination of Lee et al. and Ross et al. does not teach claim 9 which recites, inter alia, electron beam treatment of a SiN gate sidewall with a sufficiently high electron dosage to reduce a H content of substantially an entire thickness of the SiN gate sidewall.

As explained above, Lee et al. does not teach electron beam treatment, but instead teaches an ion implantation process to implant fluorine atoms into a silicon nitride layer. Lee et al. further teaches that the implanted fluorine atoms capture hydrogen atoms in the silicon nitride to fix the rapidly defusing hydrogen atoms in their original locations. A process of implanting fluorine atoms to attach to hydrogen atoms so that the hydrogen atoms do not diffuse has little or nothing to do with the claimed electron beam treatment to remove an H content of a SiN gate sidewall. Clearly the

Examiner will recognize that fluorine ions are not electron beams. Also removing H content is not the same as fixing hydrogen atoms in location by attaching them to a fluorine atom.

In fact the Examiner fully acknowledges that "Lee does not explicitly disclose electron beam treating the SiN gate sidewall with a sufficiently high electron dosage as recited in the applicants' claimed invention."

Ross et al. does not make up for the deficiencies of Lee et al.. Ross et al. teaches a method of treating a dielectric polymer not treating a SIN gate sidewall as claimed. Further, Ross et al. teaches electron treatment of the polymer film to remove moisture and contaminants from the surface of the film. Ross et al. does not teach removing H from substantially the entire thickness of a SiN gate sidewall as claimed.

In fact, as acknowledged by the Examiner, Ross et al. does not explicitly disclose treating silicon nitride with a sufficiently high electron dosage to reduce a H content of the silicon nitride. Ross et al. teaches selecting an electron dosage that reaches only into 1000 angstroms of the surface of a polymeric film and not an entire thickness of a gate sidewall. By teaching treatment of only the surface of the polymer dielectric film, Ross et al. does not suggest or teach an electron dosage sufficient for removing H content from an entire thickness of a SiN gate sidewall.

Thus, the combination of Lee et al. and Ross et al. simply does not support the Examiner's rejection. As admitted by the Examiner, Lee et al. does not disclose treating a silicon nitride film with a sufficiently high electron dosage to reduce a H content of the silicon nitride film; instead Lee et al. teaches a fluorine ion implantation process to fix hydrogen atoms into position. Ross et al. teaches surface treatment of a dielectric polymer and does not mention bulk treatment of a SiN gate sidewall. Neither Lee et al. nor Ross et al. teach or suggest treatment of a SiN gate sidewall to reduce its H content through substantially the entire thickness of the gate sidewall, nor the advantages obtained from such a treatment.

For these reasons, the combination of Lee et al. and Ross et al. do not teach electron beam treatment of a SiN gate sidewall in an electron dosage sufficient to reduce a H content through substantially the entire thickness of the SiN gate sidewall, as claimed in claim 9, and the claims dependent therefrom.

3. The Examiner rejected claims 19 and 20 under 35 USC 103(a) as unpatentable since over Ross (USP 6,548,899) in view of Lee et al. (USP 6,664,172).

Ross et al. and Lee et al do not teach amended claim 19 which recites, inter alia, electron beam treatment of an silicon nitride film by exposing the silicon nitride film to electron beam current at doses in a range from about 100 $\mu C/cm^2$ to about 1000 $\mu C/cm^2$ to reduce the H content of the silicon nitride film through substantially the entire thickness of the silicon nitride film.

Ross et al. only teaches surface treatment by teaching that "the electron beam radiation is concentrated at a distance within about 1,000 angstroms from the surface of the dielectric layer, under vacuum conditions to remove substantially all moisture and/or contaminants from the surface of the dielectric layer at a depth of up to about 1,000 angstroms from the surface of the dielectric layer." (Abstract.) Ross et al. does not teach reducing the H content of a silicon nitride film through substantially the entire thickness of the silicon nitride film. Ross et al. also does not teach electron beam treatment of a silicon nitride film with an electron beam current having a dose in a range from about 100 $\mu C/cm^2$ to about 1000 $\mu C/cm^2$ as claimed. Further Ross et al. does not teach treating silicon nitride.

Lee et al. does not teach any electron beam treatment at all. Instead, Lee et al. teaches a fluorine ion implantation process to provide implanted fluorine atoms that capture hydrogen atoms to fix the hydrogen atoms in their locations. A process of implanting fluorine atoms to attach to hydrogen atoms so that the hydrogen atoms do not diffuse has little or nothing to do with the claimed electron beam treatment to remove an H content of a silicon nitride film. Lee et al. also does not teach electron

beam treatment in a dose in a range from about 100 $\mu C/cm^2$ to about 1000 $\mu C/cm^2$ as claimed.

Thus, the combination of Ross et al. and Lee et al. simply does not teach electron beam treatment of an silicon nitride film by exposing the silicon nitride film to electron beam current at doses in a range from about 100 $\mu C/cm^2$ to about 1000 $\mu C/cm^2$ to reduce the H content of the silicon nitride film through substantially the entire thickness of the silicon nitride film. Ross et al. teaches surface treatment of a polymer and Lee et al. teaches a fluorine ion implantation process. Neither Ross et al. nor Lee et al. teach or suggest treatment of a silicon nitride film with an electron beam current at doses in a range from about 100 $\mu C/cm^2$ to about 1000 $\mu C/cm^2$ or the advantages obtained from such a treatment.

For these reasons, claims 19 and 20 are patentable over Ross et al. and Lee et al.

CONCLUSION

The above-discussed amendments are believed to place the present application in condition for allowance. Should the Examiner have any questions regarding the above remarks, the Examiner is requested to telephone Applicant's representative at the number listed below.

Respectfully submitted,
JANAH & ASSOCIATES, P.C.

Date: August 29, 2005

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